

WHAT IS CLAIMED IS:

1. A method comprising

providing a substrate,

forming a first layer on the substrate, wherein the first layer has a dielectric
5 constant of less than 3.0 and comprises an organic polymer,

applying an organosilicate precursor over the first layer, wherein the
precursor is selected from the group consisting of curable polymers based on (i)
divinylsiloxane-bis-benzocyclobutene and (ii) hydrolyzed products of at least one
alkoxysilane or acyloxysilane,

10 curing the precursor to form an organosilicate resin

removing a portion of the organosilicate resin to expose a portion of the first
layer, and

removing the exposed portions of the first layer.

2. The method of Claim 1 wherein the substrate comprises an active
15 substrate containing transistors.

3. The method of Claim 1 wherein the organic polymer is a polyarylene.

4. The method of Claim 3 wherein the organic polymer is the reaction
product of a cyclopentadienone functional compound and an acetylene functional
compound.

20 5. The method of Claim 1 wherein the first layer is porous.

6. The method of Claim 1 wherein the organosilicate resin is a cured
reaction product of divinylsiloxane-bis-benzocyclobutene monomers.

7. The method of Claim 1 wherein the organosilicate resin is a cured
product of hydrolyzed alkoxysilanes, hydrolyzed acyloxysilanes, or a combination thereof.

8. The method of Claim 1 wherein the organosilicate resin is photodefinable.

9. The method of Claim 8 wherein the step of removing a portion of the organosilicate resin comprises exposing the organosilicate to activating wavelengths of radiation to cause polymerization reaction where exposed and removing the unexposed portions of the organosilicate with a suitable developer.

10. The method of Claim 1 wherein the portions of the first layer are removed by etching.

11. The method of Claim 10 wherein etching comprises RIE type of plasma etch using oxygen, nitrogen, helium, argon, C_xF_y , $C_xH_yF_z$, C_xH_y , W_xF_y or mixtures thereof.

12. The method of Claim 1 wherein the step of removing a portion of the organosilicate comprises applying a photoresist over the organosilicate, exposing a portion of the photoresist to activating radiation, developing a photoresist to reveal a portion of the organosilicate, and etching the organosilicate.

13. The method of Claim 12 wherein the etching step comprises RIE type of plasma etch using oxygen, nitrogen, helium, argon, C_xF_y , $C_xH_yF_z$, C_xH_y , W_xF_y or mixtures thereof.

14. The method of Claim 1 further comprising applying a conductive metal in at least some of the regions where the first layer was removed.

15. The method of Claim 1 further comprising adding a second layer having a dielectric constant of less than 3.0 over the organosilicate resin, forming a patterned hardmask over the second layer, and etching the second layer.

16. The method of Claim 15 wherein the etching comprises etching through the second layer to the organosilicate material and, where the organosilicate was previously removed, etching into the first layer.

17. The method of Claim 15 wherein the second layer is applied and etched before the step of removing a portion of the organosilicate layer.

18. The method of claim 7 wherein the organosilicate resin is the cured reaction product of hydrolyzed silanes and the silanes prior to hydrolysis comprise

(a) an alkoxysilane or acyloxysilane having at least one hydrocarbon group attached directly to the Si atom which hydrocarbon group contains a non-aromatic,

5 unsaturated carbon to carbon bond, and

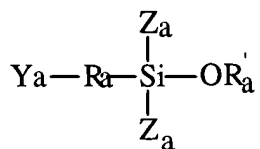
(b) an alkoxysilane or acyloxysilane having at least one hydrocarbon group attached directly to the Si atom which hydrocarbon group includes an aromatic ring.

19. The method of claim 18 wherein the silanes further comprise

(c) an alkoxysilane or acyloxysilane having at least one C₁-C₆ alkyl group
10 attached directly to the Si atom.

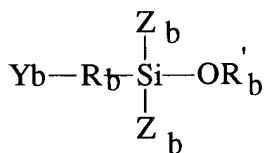
20. The method of claim 18 wherein the silanes comprise

(a) 50-95 mole% silanes of the formula



wherein R_a is C₁-C₆ alkylidene, C₁-C₆ alkylene, arylene, or a direct bond; Y_a is C₁-C₆
15 alkyl, C₂-C₆ alkenyl, C₂₋₆ alkynyl, C₆-C₂₀ aryl, 3-methacryloxy, 3-acryloxy, 3-aminoethyl-
amino, 3-amino, -SiZ_{a2}OR_a', or -OR_a'; R_a' is independently, in each occurrence, a C₁-C₆
alkyl or C₂-C₆ acyl; and Z_a is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂₋₆ alkynyl, C₆₋₂₀ aryl, or -
OR_a', provided at least one of Z_a or the combination R_a-Y_a comprises a non-aromatic
carbon carbon bond unsaturation,

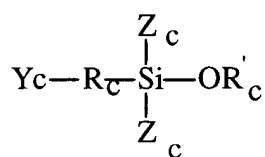
20 (b) 5 to 40 mole percent



wherein Rb is C₁-C₆ alkylidene, C₁-C₆ alkylene, arylene, or a direct bond; Yb is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂₋₆ alkynyl, C₆-C₂₀ aryl, 3-methacryloxy, 3-acryloxy, 3-aminoethyl-amino, 3-amino, -SiZb₂ORb', or -ORb'; Rb' is independently, in each occurrence, a C₁-C₆ alkyl or C₂-C₆ acyl ; and Zb is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂₋₆ alkynyl, C₆₋₂₀ aryl, or -

- 5 ORb', provided at least one of Zb or the combination of Rb-Yb comprises an aromatic ring, and.

(c) 0 to 45 mole percent



wherein Rc is C₁-C₆ alkylidene, C₁-C₆ alkylene, arylene, or a direct bond;

- 10 Yc is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂₋₆ alkynyl a C₆-C₂₀ aryl, 3-methacryloxy, 3-acryloxy, 3-aminoethyl-amino, 3-amino, -SiZc₂ORc', or -ORc'; Rc' is independently, in each occurrence, a C₁-C₆ alkyl or C₂-C₆ acyl ; and Zc is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂₋₆ alkynyl, C₆₋₂₀ aryl, or -ORc', provided at least one of Zc or the combination of Rc-Yc comprises an alkenyl.

- 15 21. The method of claim 18 wherein the first silane (a) is a vinyl acetoxy silane and the second silane (b) is an arylalkoxysilane.

- 20 22. An integrated circuit article comprising an active substrate containing transistors and an electrical interconnect structure containing patterned metal lines separated, at least partially, by layers or regions having a dielectric constant of less than 3.0 and comprising an organic polymer, wherein the article further comprises a layer of an organosilicate resin immediately above and in contact with at least one layer of the organic polymer material wherein the organosilicate resin is the cured reaction product of a precursor selected from divinylsiloxane bis benzocyclobutene based oligomers and hydrolyzed products of at least one alkoxysilane or acyloxysilane.

23. The article of claim 22 wherein the organosilicate resin is the hydrolyzed product of silanes comprising

(a) an alkoxysilane or acyloxysilane having at least one hydrocarbon group attached directly to the Si atom which hydrocarbon group contains a non-aromatic,

5 unsaturated carbon to carbon bond, and

(b) an alkoxysilane or acyloxysilane having at least one hydrocarbon group attached directly to the Si atom which hydrocarbon group includes an aromatic ring.

24. A composition comprising the hydrolyzed or partially hydrolyzed product of a combination of silanes comprising

10 (a) an alkoxysilane or acyloxy silane having at least one hydrocarbon group attached directly to the Si atom which hydrocarbon group contains a non-aromatic, unsaturated carbon to carbon bond, and

(b) an alkoxysilane or acyloxysilane having at least one hydrocarbon group attached directly to the Si atom which hydrocarbon group includes an aromatic ring.

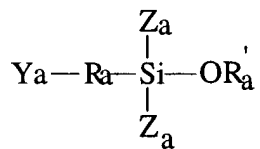
15 25. The composition of claim 24 wherein the combination further comprises

(c) an alkoxysilane or acyloxysilane having at least one C₁-C₆ alkyl group attached directly to the Si atom.

20 26. The composition of claim 24 wherein the first silane (a) is a vinyl acetoxy silane and the second silane (b) is an arylalkoxysilane.

27. The composition of claim 24 wherein the combination comprises

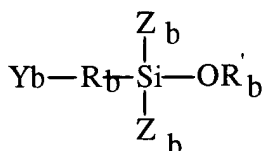
(a) 50-95 mole% silanes of the formula



wherein R_a is C₁-C₆ alkylidene, C₁-C₆ alkylene, arylene, or a direct bond; Y_a is C₁-C₆

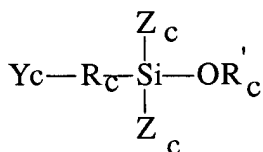
alkyl, C₂-C₆ alkenyl, C₂₋₆ alkynyl, C₆-C₂₀ aryl, 3-methacryloxy, 3-acryloxy, 3-aminoethyl-
 amino, 3-amino, -SiZa₂ORa', or -ORa'; Ra' is independently, in each occurrence, a C₁-C₆
 alkyl or C₂-C₆ acyl; and Za is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂₋₆ alkynyl, C₆₋₂₀ aryl, or -
 ORa', provided at least one of Za or the combination Ra-Ya comprises a non-aromatic
 5 carbon carbon bond unsaturation,

(b) 5 to 40 mole percent



wherein Rb is C₁-C₆ alkylidene, C₁-C₆ alkylene, arylene, or a direct bond; Yb is C₁-C₆
 alkyl, C₂-C₆ alkenyl, C₂₋₆ alkynyl, C₆-C₂₀ aryl, 3-methacryloxy, 3-acryloxy, 3-aminoethyl-
 10 amino, 3-amino, -SiZb₂ORb', or -ORb'; Rb' is independently, in each occurrence, a C₁-C₆
 alkyl or C₂-C₆ acyl; and Zb is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂₋₆ alkynyl, C₆₋₂₀ aryl, or -
 ORb', provided at least one of Zb or the combination of Rb-Yb comprises an aromatic ring,
 and

(c) 0 to 45 mole percent



wherein Rc is C₁-C₆ alkylidene, C₁-C₆ alkylene, arylene, or a direct bond;
 Yc is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂₋₆ alkynyl, C₆-C₂₀ aryl, 3-methacryloxy, 3-acryloxy,
 3-aminoethyl-amino, 3-amino, -SiZc₂ORc', or -ORc'; Rc' is independently, in each
 occurrence, a C₁-C₆ alkyl or C₂-C₆ acyl; and Zc is C₁-C₆ alkyl, C₂-C₆ alkenyl, C₂₋₆
 20 alkynyl, C₆₋₂₀ aryl, or -ORc', provided at least one of Zc or the combination of Rc-Yc
 comprises an alkenyl.

28. The use of the composition of claim 24 as an adhesion promoter.

